Forces & Motion

Physical Science

I. Force- push or pull that one object exerts on another

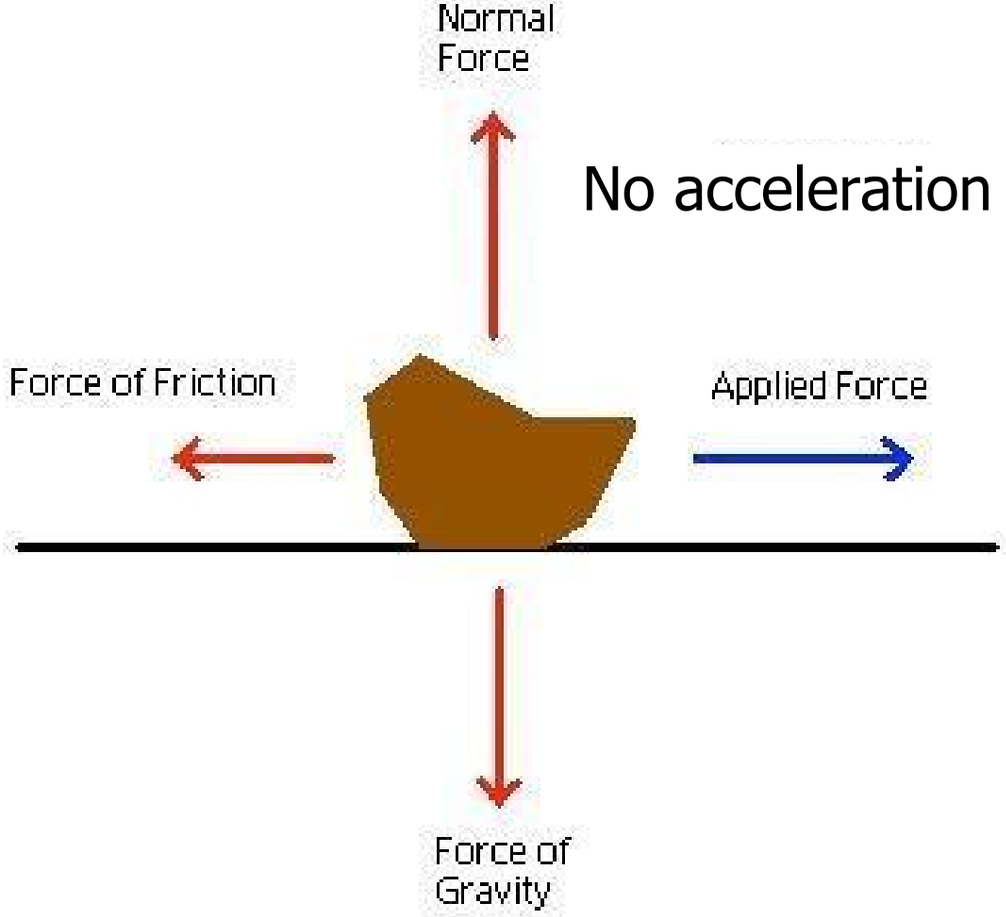
- Examples: hitting a baseball, throwing a basketball, etc.

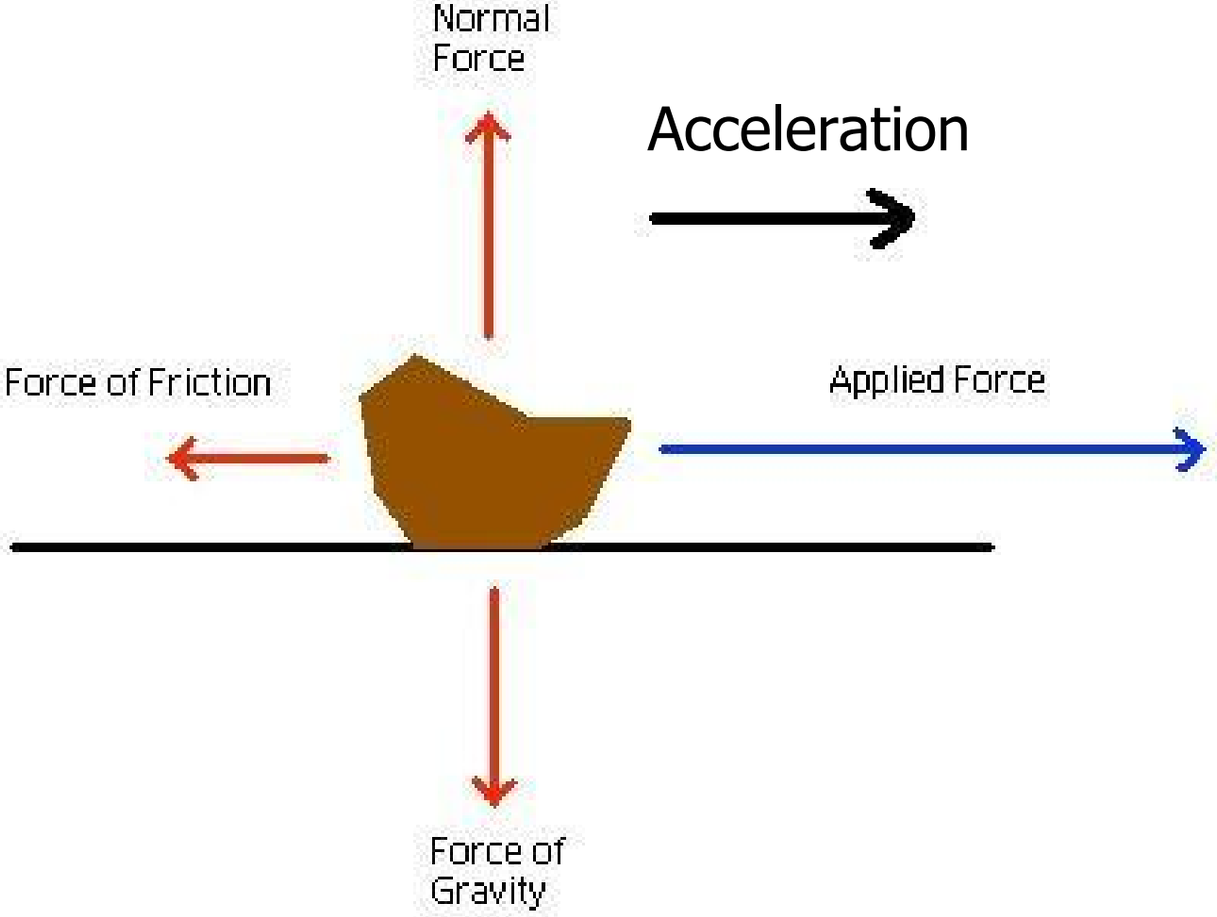
– Forces aren't always noticeable

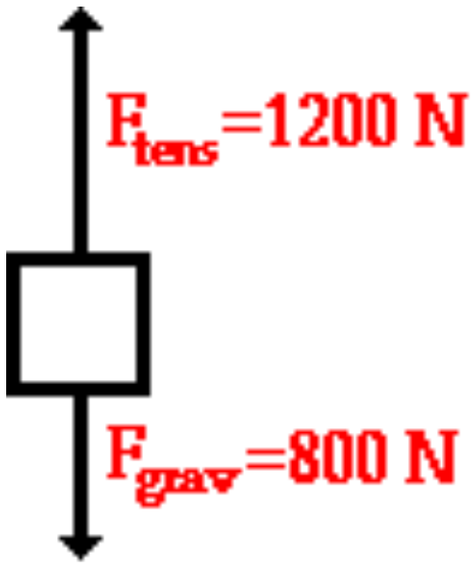
- Floor pushes up on you- otherwise you'd fall

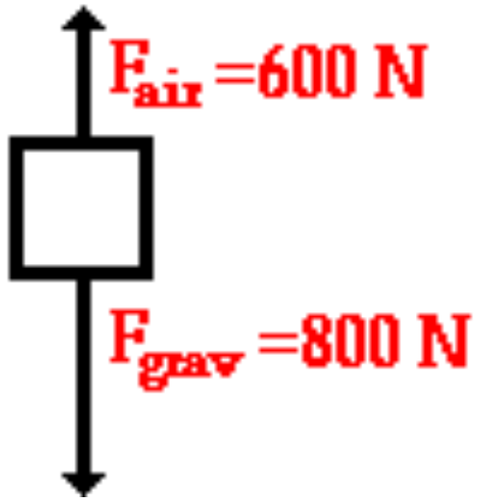
– Forces influence motion

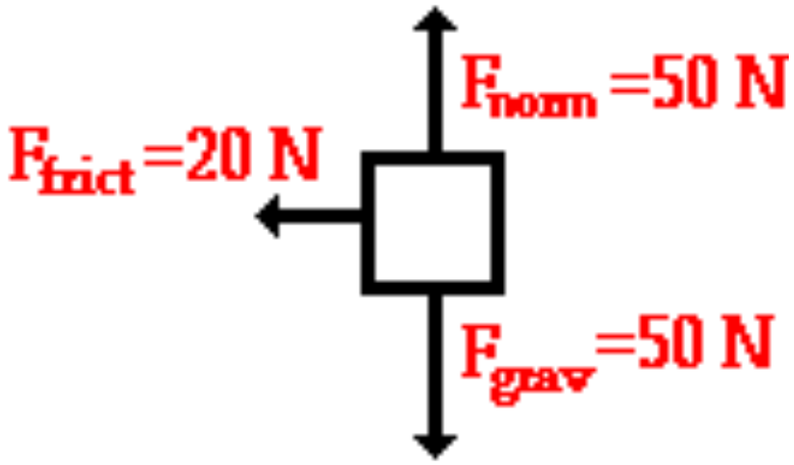
- Unbalanced forces change the velocity of an object - either the speed or direction of an object






F_{tens}=1200 N
F_{grav}=800 N


F_{air} =600 N
F_{grav} =800 N


F_{norm} =50 N
F_{frict}=20 N
F_{grav}=50 N

Force Diagrams

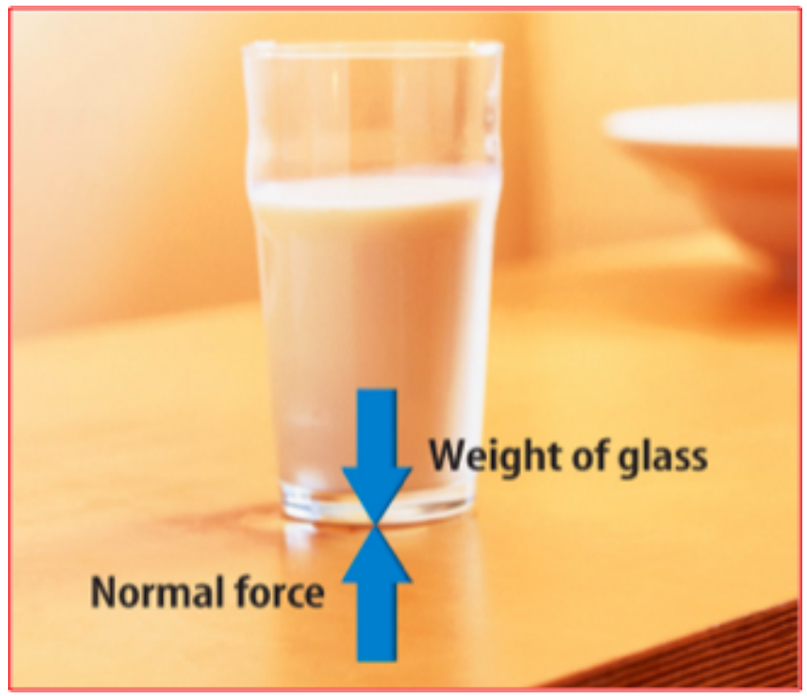
When two vector arrows show a force acting on the same object, and the forces are acting in opposite directions, SUBTRACT the values to get the NET FORCE

When two vector arrows show a force acting on the same object, and the forces are acting in the same direction, ADD the values to get the NET FORCE

The forces on the person are balanced.

Types of forces:

_____: is a force that is applied to an object by a person or another object.



_____: the perpendicular support force exerted upon an object that is in contact with another stable object.

_____ : Force that opposes motion of two objects IN CONTACT

- static - rolling -sliding -air resistance - fluid -

Frictional Forces

static - results when the surfaces of two objects are at rest relative to one another and a force exists on one of the objects to set it into motion relative to the other object.

sliding - results when an object slides across a surface.

rolling - rolling friction refers to the resistance created by an object rolling across a surface (ex: wheel, ball, tire)

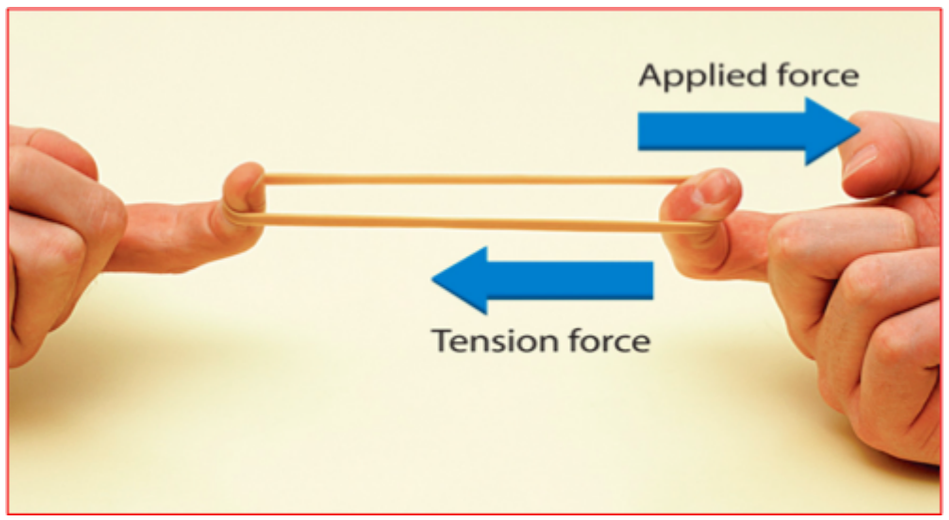
air resistance - a special type of frictional force that acts upon objects as they travel through the air. Air resistance is often so small it is not considered, it is dependant on the shape and size of an object.

fluid (liquid) - similar to air resistance but has a higher impact because the particles in a liquid are closer together and create a larger “drag” on an object

Types of forces:

_____: Force of attraction between two masses - increases with mass increase…. here on earth gravitational force = weight = the mass of an object * the acceleration of gravity. Weight changes from place to place

_____: force when an object is stretched (rubber band)



_____: force when an object is compressed aka spring force

II. Inertia- an object's resistance to a change in motion

A. If moving; stays moving

B. If stopped; stays stopped

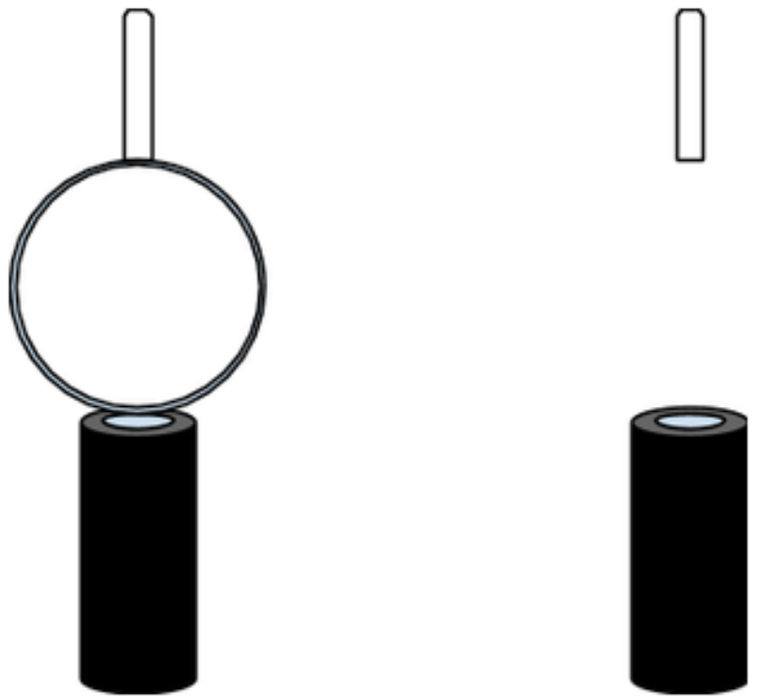
III. Newtons 1st law of motion : Objects will stay in constant motion, or at rest, unless acted on by a NET force.

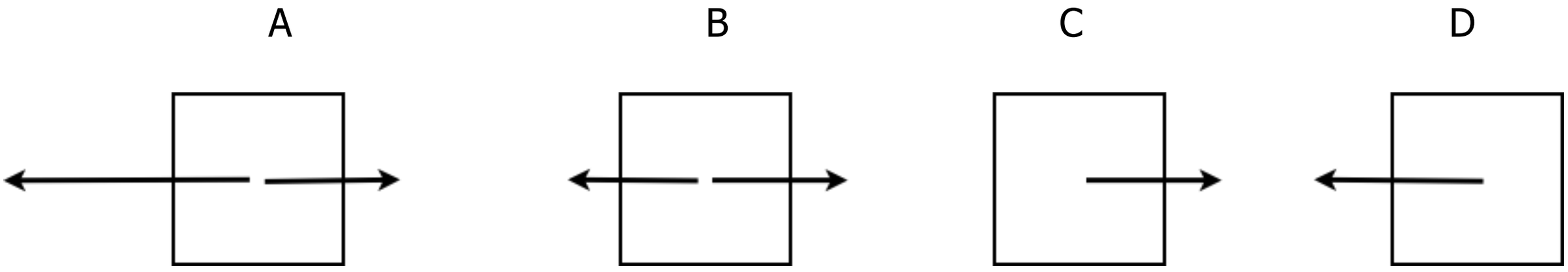
A. Known as the law of inertia

With the hoop sitting on the solenoid, and marker sitting on the hoop, remove the hoop in a way that the marker falls straight down into the solenoid.

Draw what you think are the forces acting on the marker as it sits on top of the hoop.

Draw what you think are the forces acting on the maker immediately after the hoop is removed.





Which diagram above shows a force diagram for a car traveling at a constant velocity to the right.

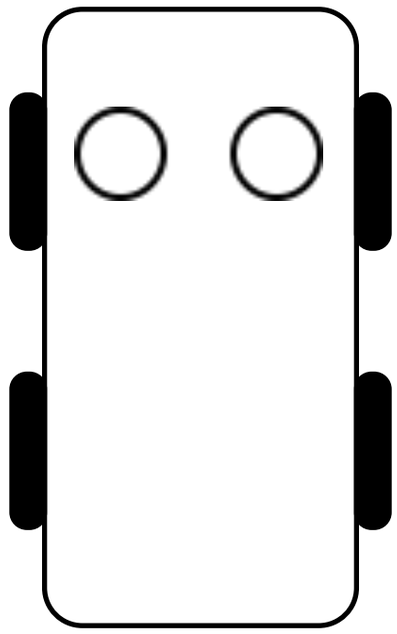
What device was added to cars to help protect passengers for when a car takes off at a green light?

A. Head Rest

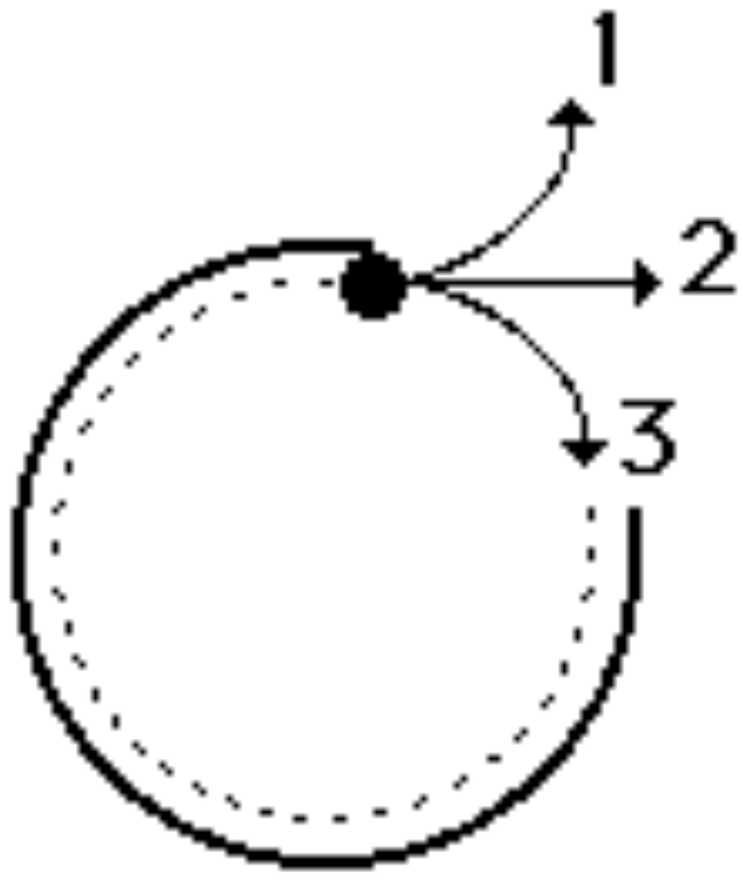
B. Air Bag

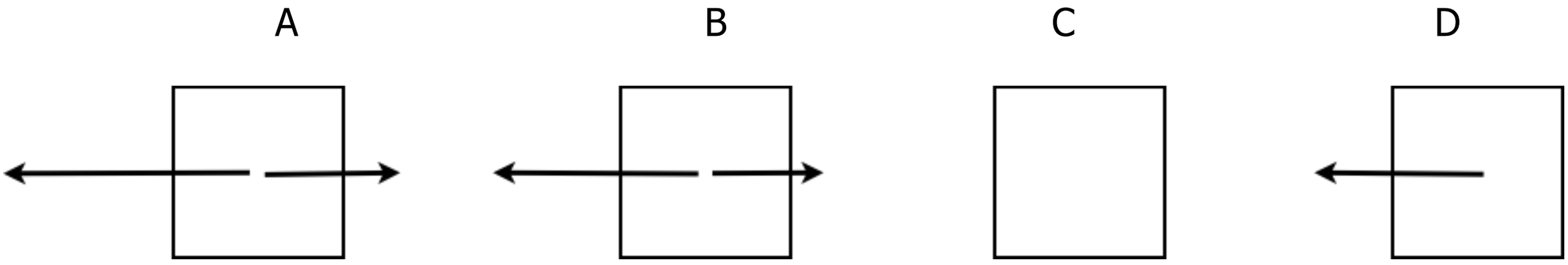
C. Seat Belt

D. Steering Wheel



In which direction will a ball travel after moving around a circular path





If a spaceship fired a cannonball into frictionless space, what diagram above shows the forces needed for the ball to remain in constant motion? (The ball is moving to the left)

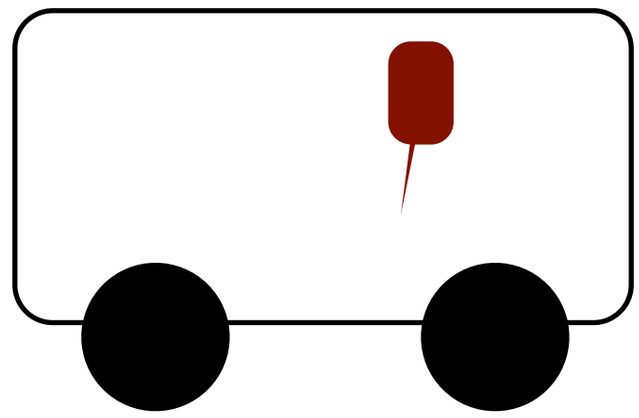
You observe a parked car with a helium balloon floating inside. When the car backs out of the parking space what is the resulting motion of the balloon?

A. Moves back with the car

B. Does not move

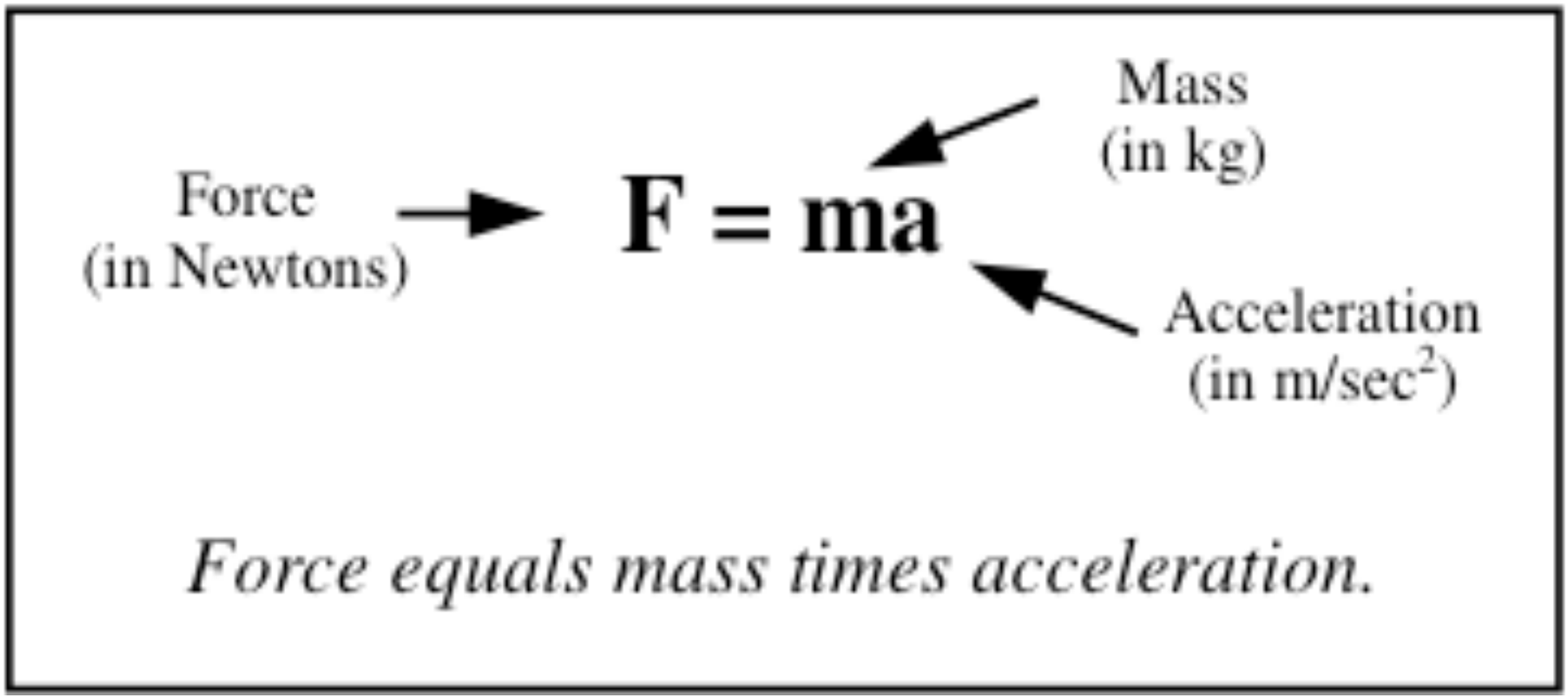
C. Moves forward

D. Floats upwards



IV. Newton's 2nd Law: Objects will accelerate when acted on by a NET force.

The acceleration is directly proportional the force applied on the object and inversely proportional to the mass of the object



Force of gravity

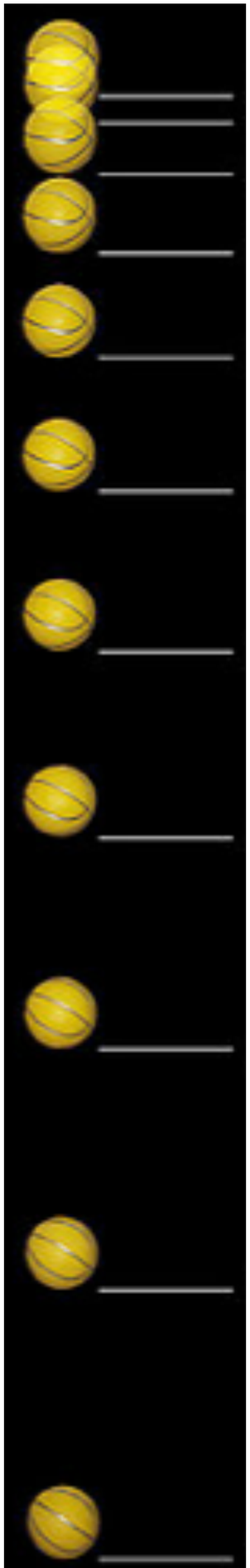
Gravity on Earth produces a constant acceleration on everything

A. It is measured to be 9.8 m/s^2 or 10 m/s^2

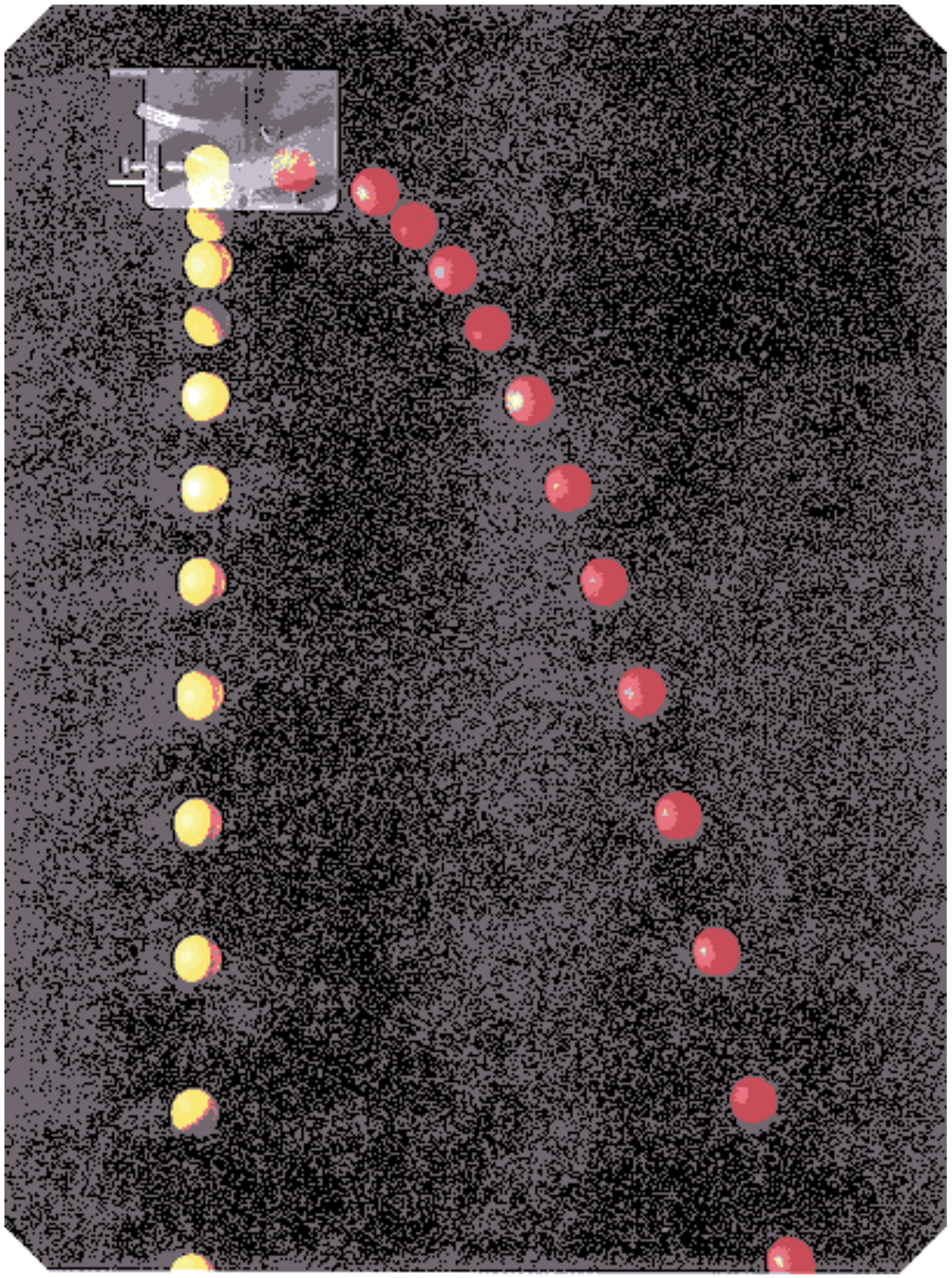
B. This means that everything should fall at the same rate of acceleration

C. The bigger an object's mass, the greater the gravitational force

$$a_g = \frac{F_g}{m} \qquad a_g = \frac{20N}{2kg} \qquad a_g = \frac{10N}{1kg}$$



Gravity



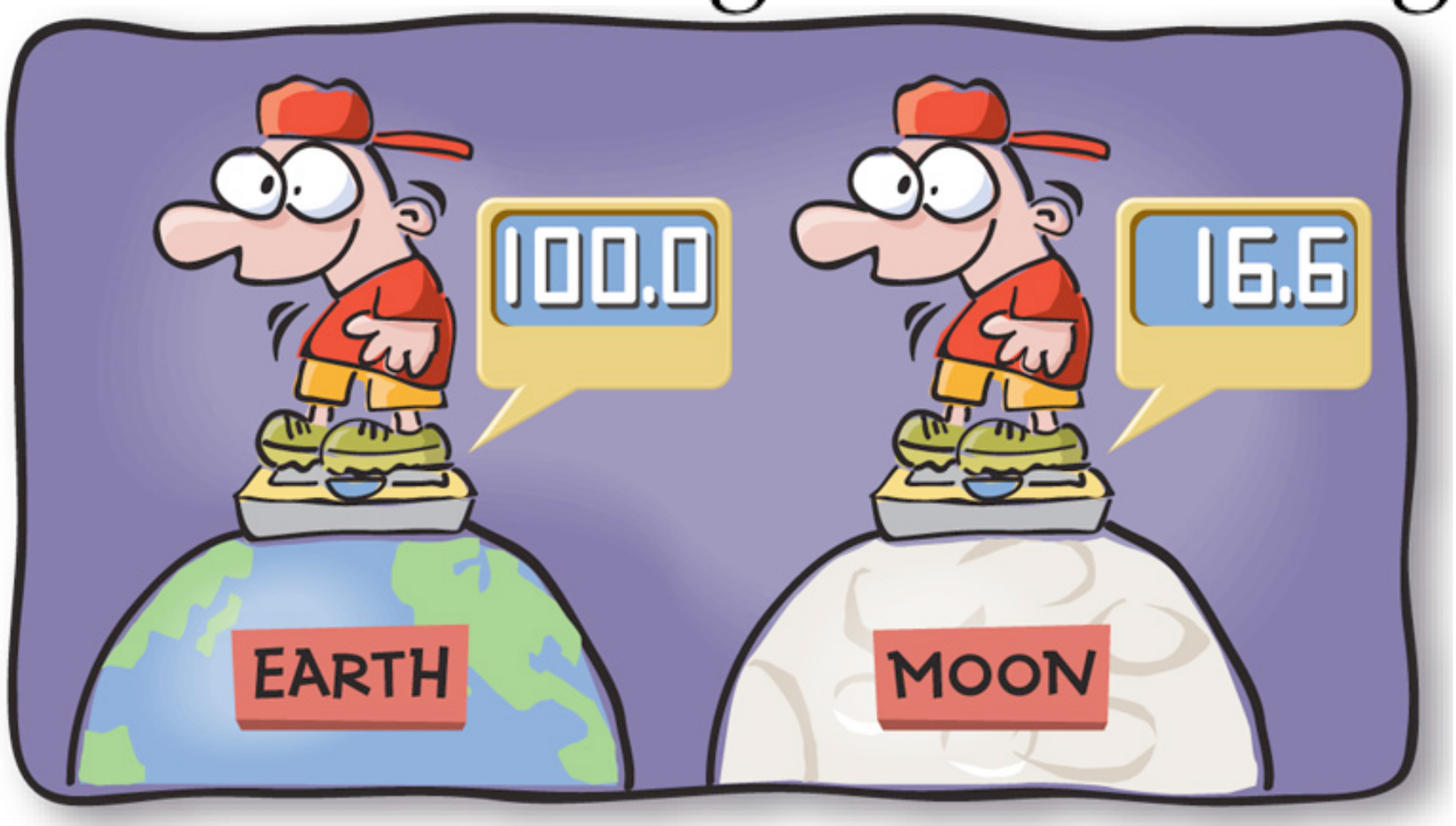
Time-lapse photography shows that each ball has the same acceleration downward, whether it's thrown or dropped.

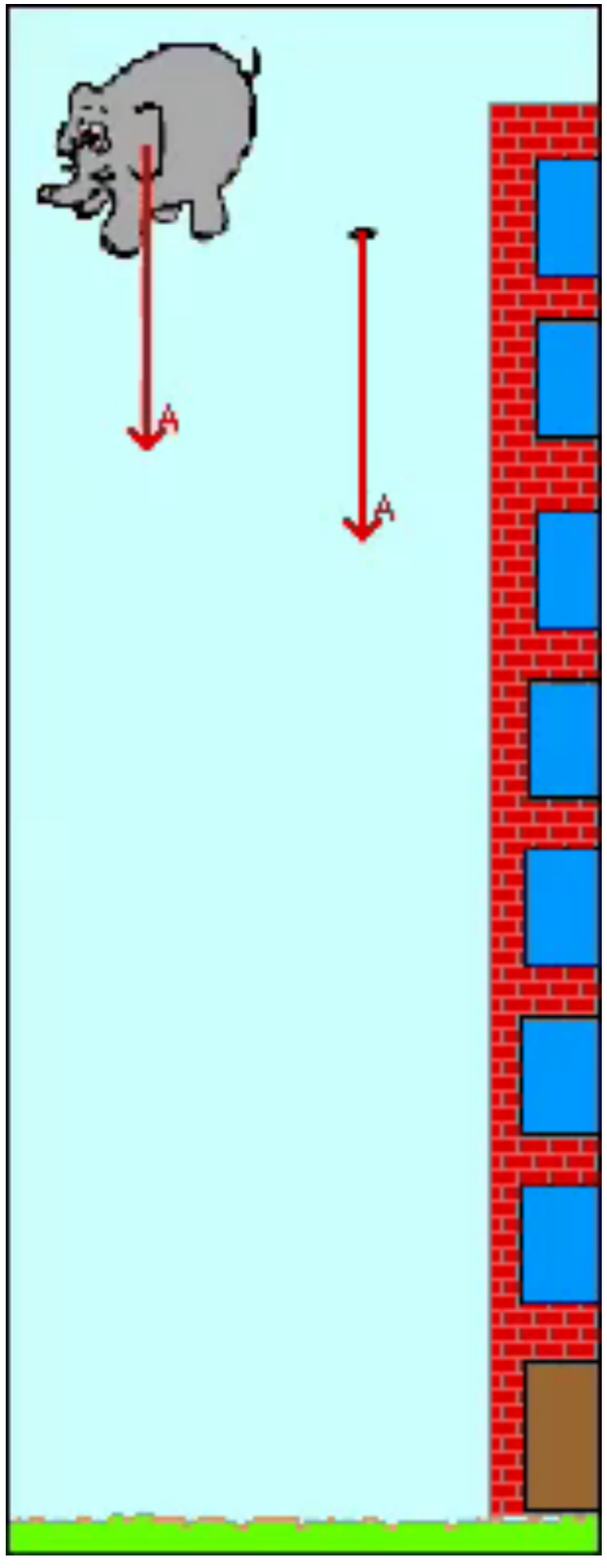
Gravitational force … aka Weight

<u>Weight</u>- gravitational force exerted on an object

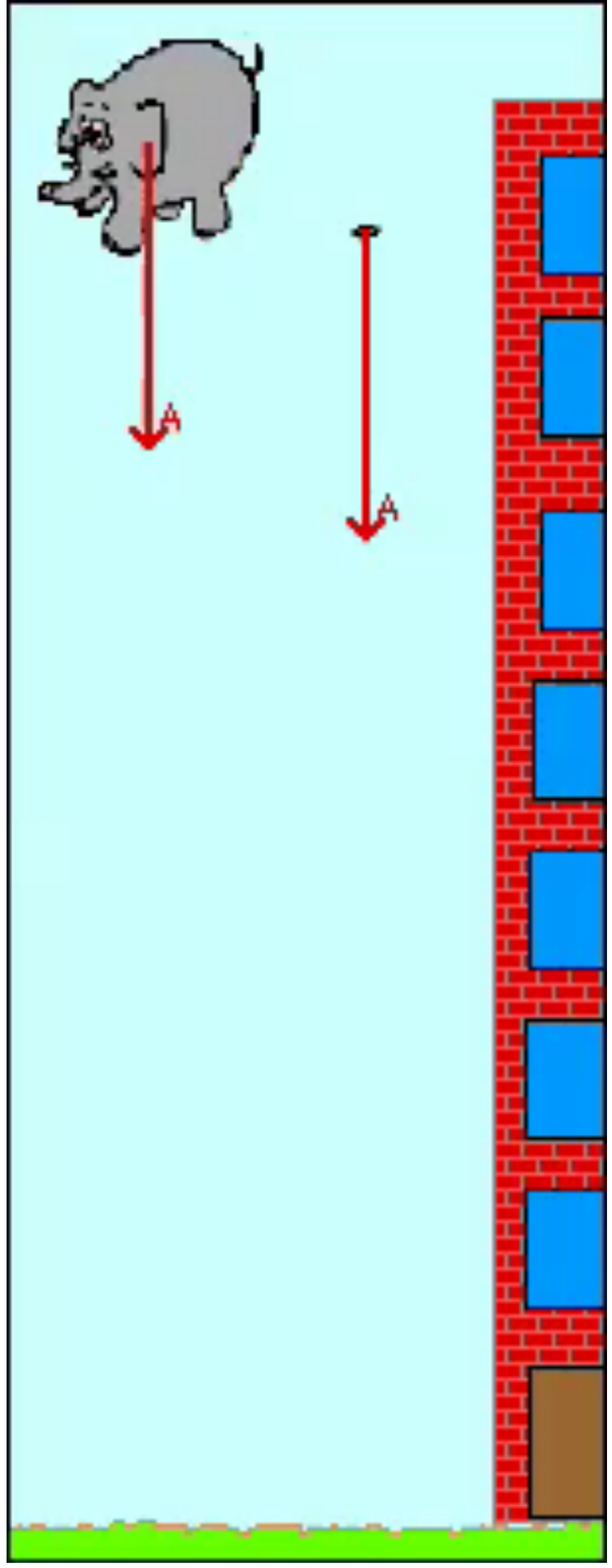
1. Weight results from a force; <u>mass</u> is how much matter an object contains

$$W = F_g = ma_g$$



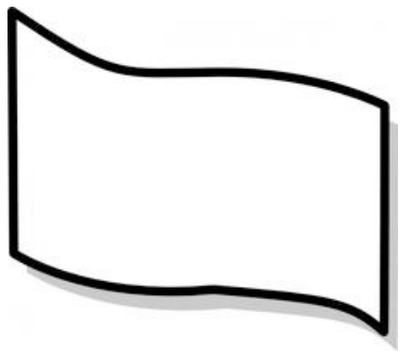


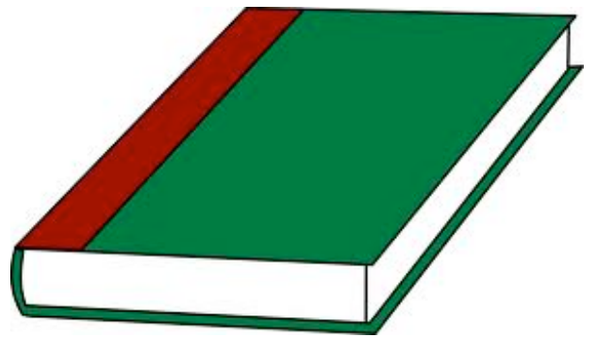
- Free fall = Any object that is being acted upon **only** by the force of gravity is said to be in a state of **free fall**.



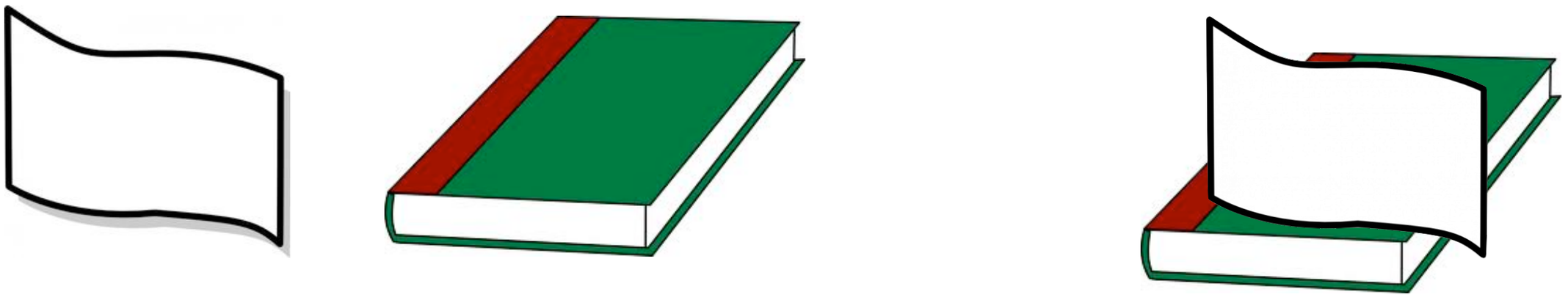
<u>Air resistance</u>- a frictional force that opposes motion

1. depends on an object's shape, size, and the speed at which the object is moving

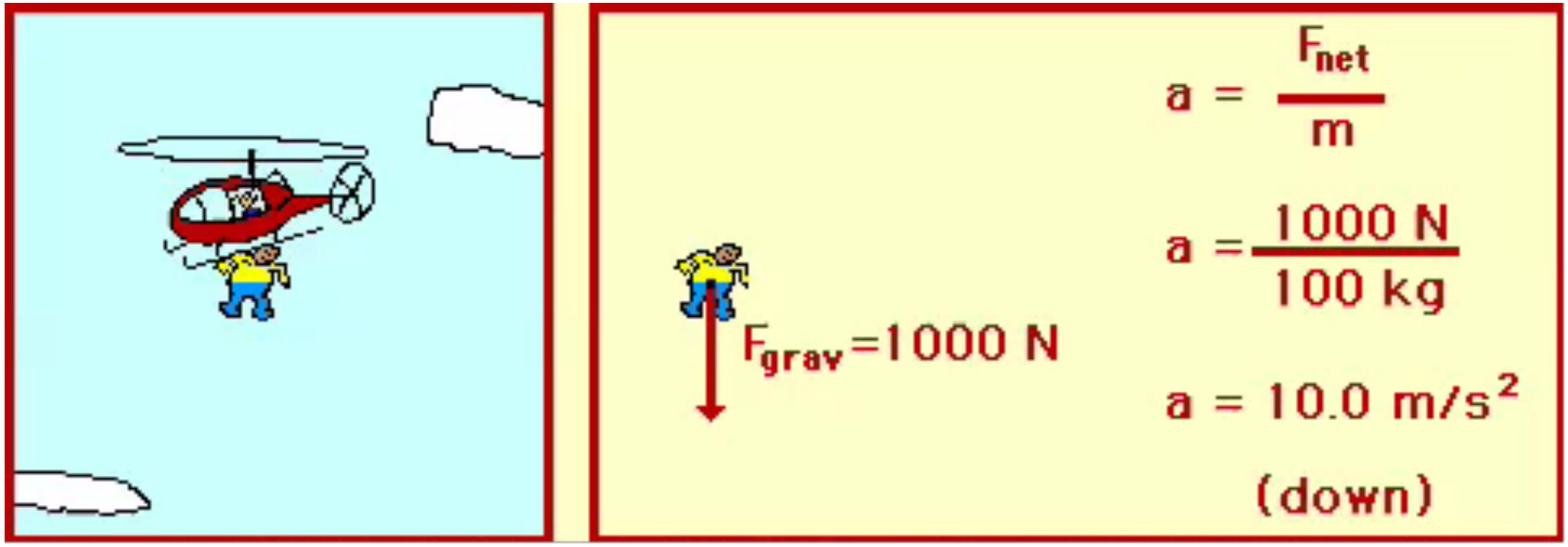




- What hits first?

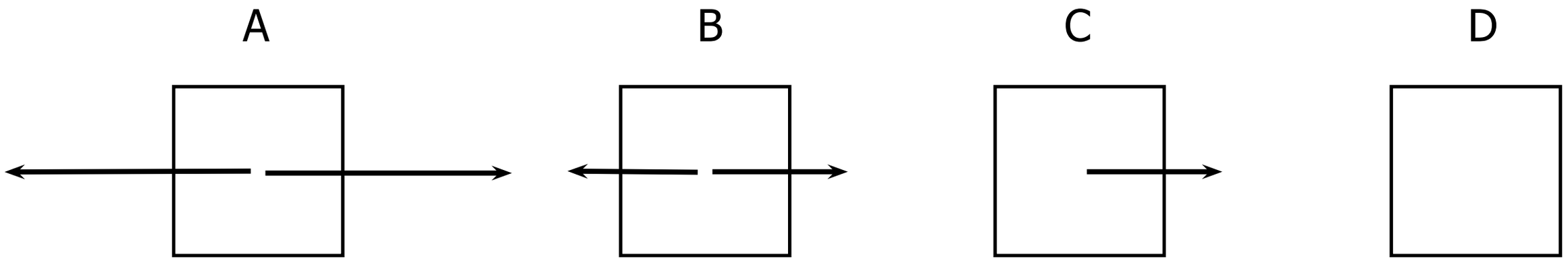


Terminal velocity- forces on a falling object are balanced and the object falls with constant speed (for humans is 120 mph)

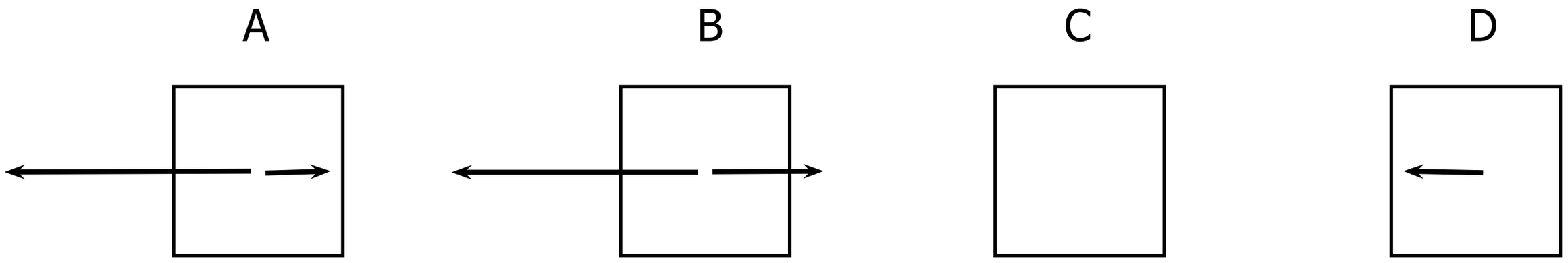


- Sitting on the skateboards, push against another group member that is on a second skateboard.
  - Who goes faster? Why?
  - Try it again and have the other group member push, who goes faster? Why?

http://www.youtube.com/watch?v=AYz_K3mwq6A



Which diagram above shows a force diagram for a car speeding up to the right.



Which object is moving to the left and is speeding up the most?

If a 50 N force pulls on a 10 kg object, what will the acceleration of the object be?

A 49 N force pulls on an object and creates an acceleration of 7 m/s^2. What is the object's mass?

A boat moves through the water with two forces acting on it. One is a 2,100 N forward push by the motor, and the other is a 1,800 N resistive force due to the water.

What is the net force acting on the boat?

What is the acceleration of the 1200 kg boat?

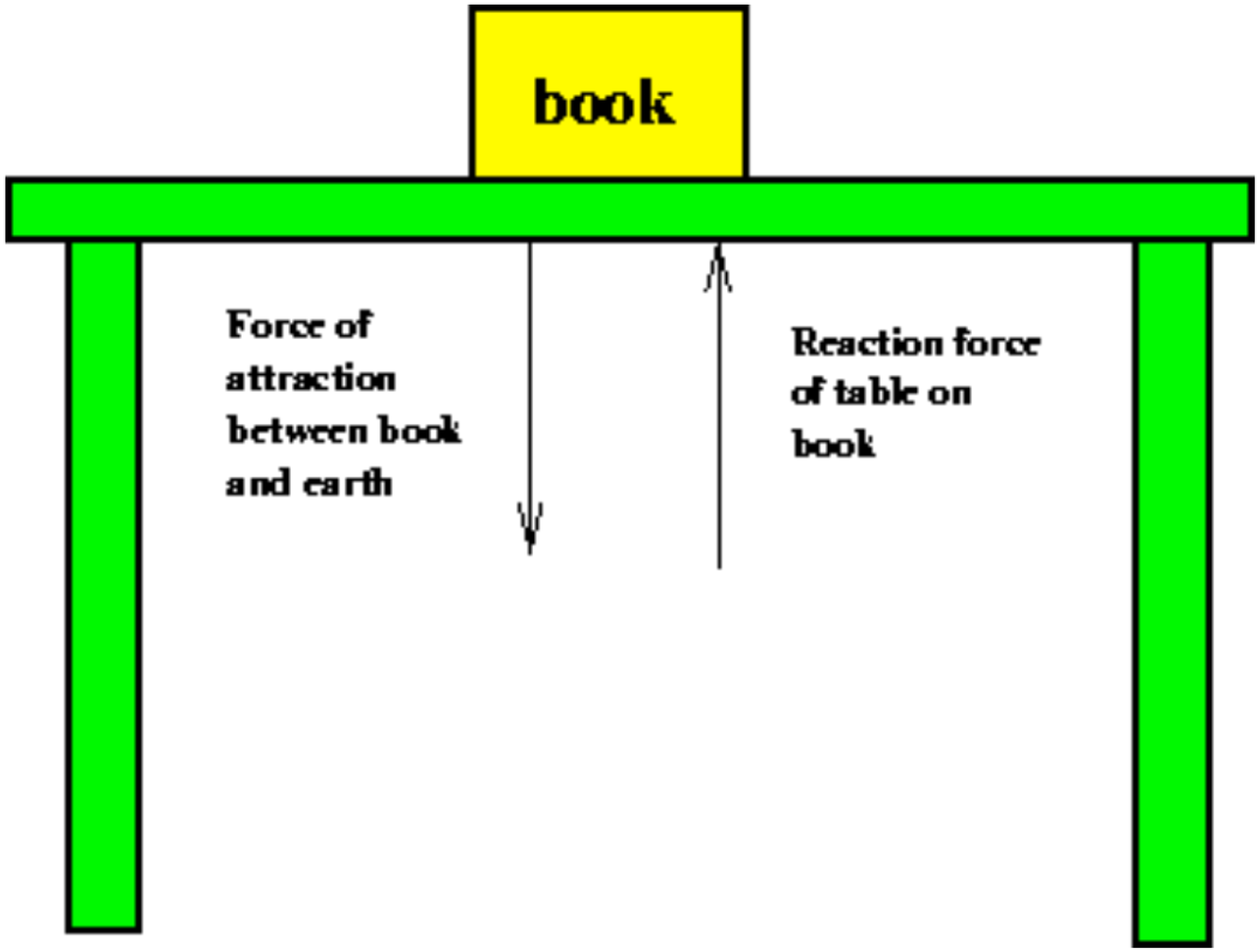
Both a bus and a sports car are stopped at a red light. When the light turns green, both vehicles accelerate at the same rate. After the first 200 m, which car is in front?

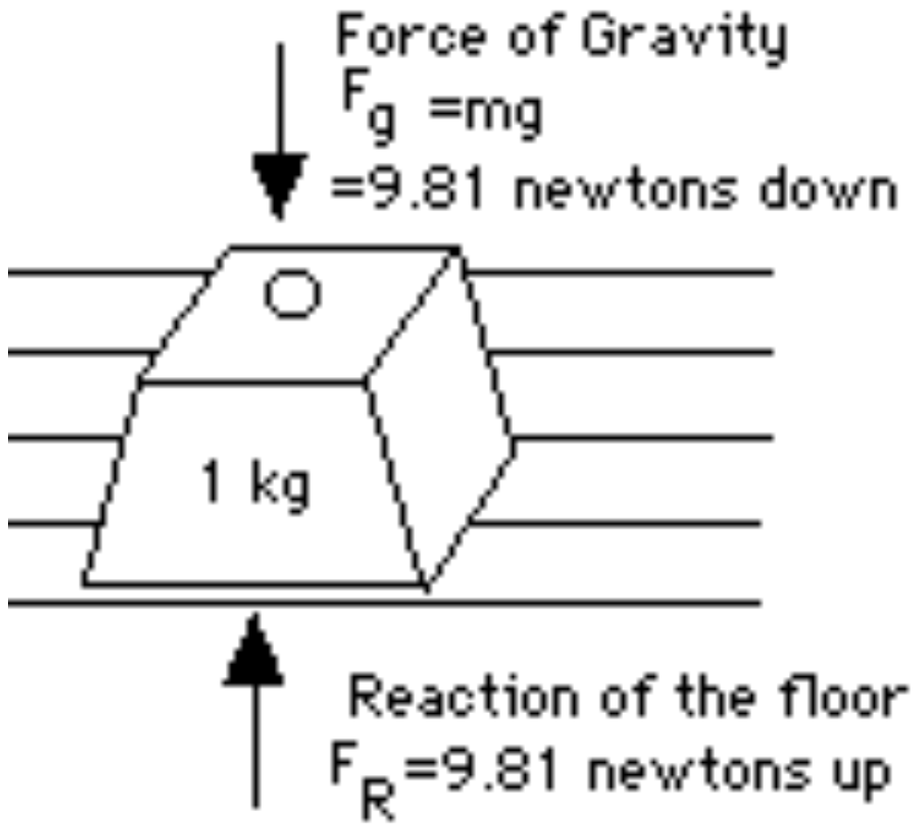
Which car has a greater net force acting on it?

V. Newton's third law of motion

A. **When 1 object exerts a force on a 2nd object, the 2nd object exerts a force that is equal in size and opposite in direction to the force from the 1st object.**

1. **For every <u>action</u>, there is an equal & opposite <u>reaction</u>**

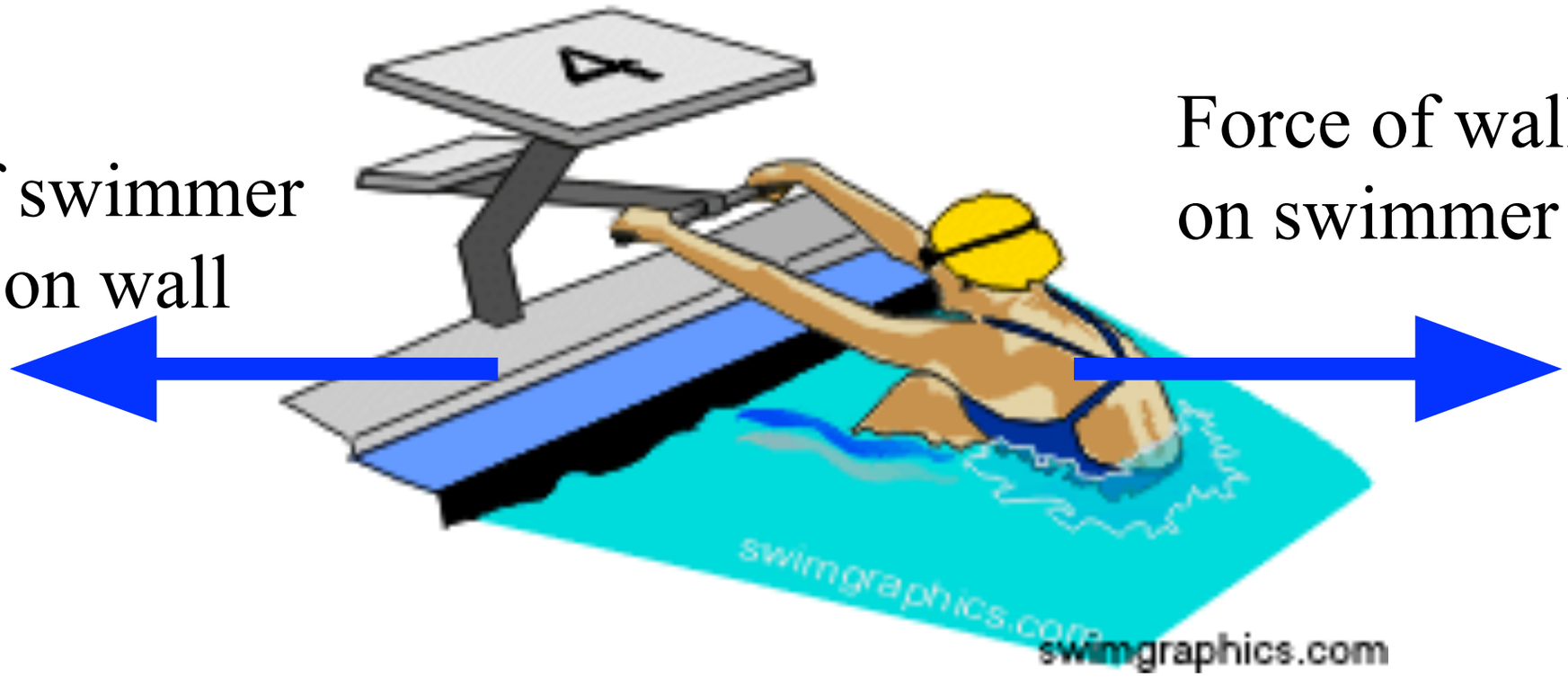




- Sitting on the skateboard try to move without pushing on anything.
- Sitting on the skateboard push on the wall
  - How does the direction of your push compare to the direction you travel in?

- **Swimming- swimmer exerts force on wall; wall exerts force on swimmer**
  - **Action-reaction pairs act on different objects**

Force of swimmer pushing on wall



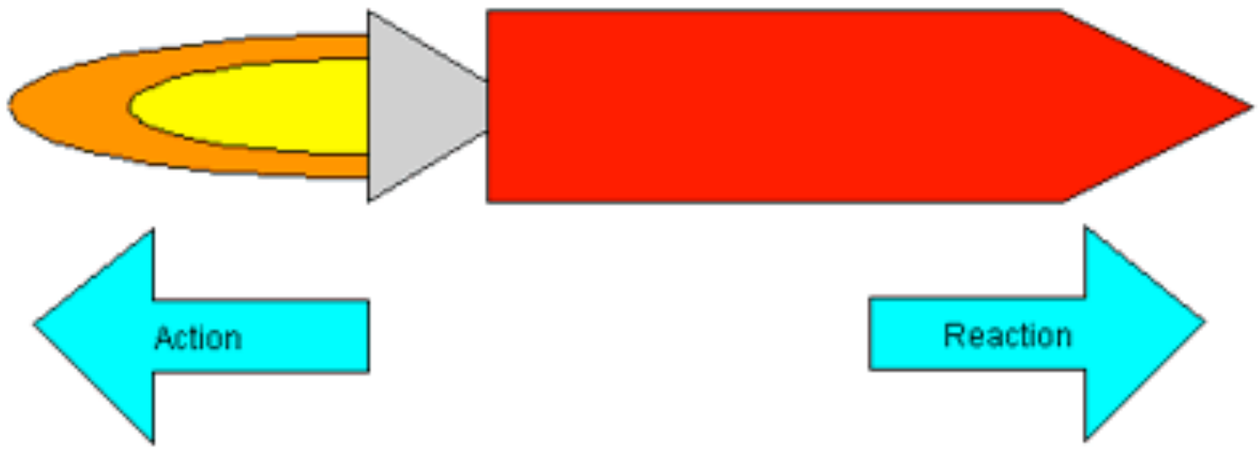
Force of wall pushing on swimmer

Forces act on different objects!

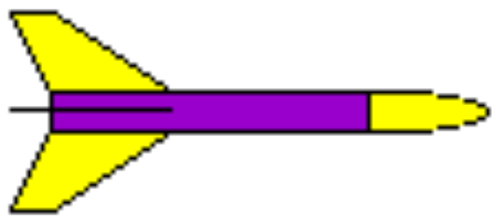
- Forces are equal but accelerations are different because mass are different
  - swimmer: lighter mass -> higher acceleration
  - wall: bigger mass - > lower acceleration

Forces act on different objects!

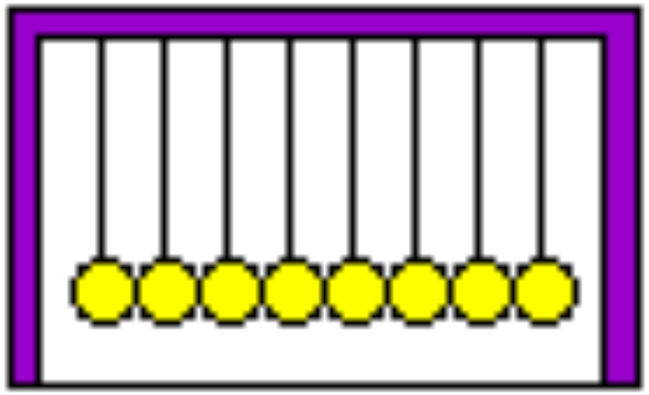
Let's study how a rocket works to understand Newton's Third Law.

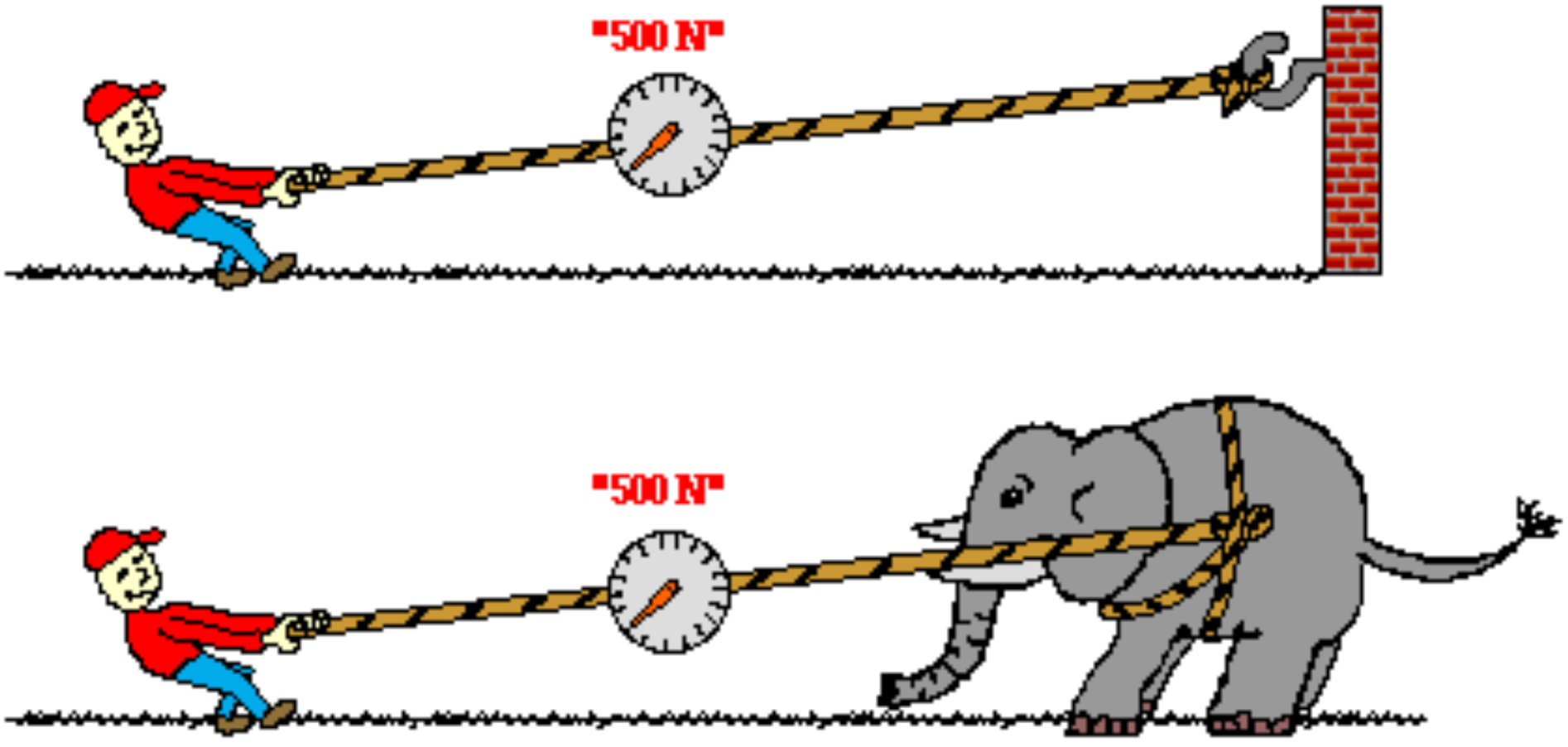


The rocket's **action** is to push down on the ground with the force of its powerful engines, and the **reaction** is that the ground pushes the rocket upwards with an equal force.



Identify the Action & Reaction Pairs





In the top picture, Mike is pulling upon a rope which is attached to a wall. In the bottom picture, the Mike is pulling upon a rope which is attached to an elephant. In each case, the force scale reads 500 Newtons. Mike is pulling …

a. with more force when the rope is attached to the wall.

b. with more force when the rope is attached to the elephant.

c. the same force in each case.

While driving down the road, a bug strikes the windshield of a bus and makes a quite obvious mess in front of the face of the driver. This is a clear case of Newton's third law of motion. The bug hit the bus and the bus hits the bug. Which of the two forces is greater: the force on the bug or the force on the bus?

THINK ?